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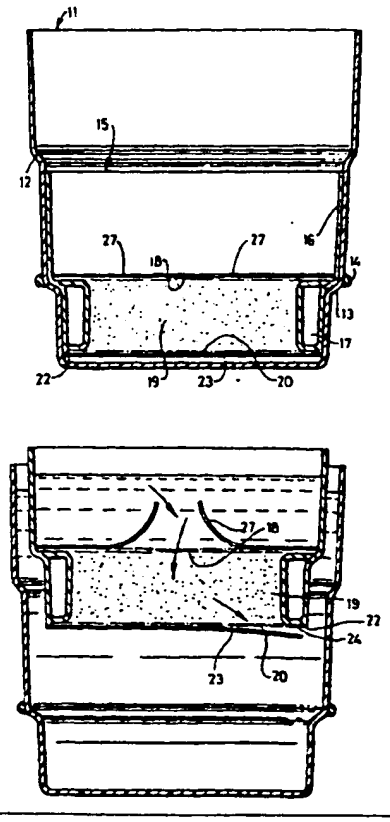
(54) Title: BEVERAGE BREWING

(57) Abstract

A method of brewing a beverage in a container such as a cup (11) comprises the steps of: providing a container having a beverage brewing capsule (15) located therein, the beverage brewing capsule comprising a beverage brewing ingredient (19) enclosed between two spaced-apart filtration barriers (18, 20), pouring hot water into the container to immerse the capsule, and causing or allowing the beverage brewing capsule to move slowly upwardly relative to the container. The movement of the capsule through the hot water in the container may be achieved by raising the capsule and/or lowering the container and/or by providing a buoyant capsule (17). The capsule (15) preferably comprises a body in the form of an open-ended tube (16) with two spaced-apart filtration barriers (18, 20) extending across the inside of the tube. The invention also provides a cup (11) having a beverage brewing capsule of the above type located in the bottom thereof, and an interlocked stack of such cups.



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BEVERAGE BREWING

The present invention relates to beverage brewing, and in particular to methods and apparatus for brewing individual cups of hot beverages such as coffee or tea.

There is a long standing need in the beverage art for means to brew individual cups of coffee or tea having the quality and organoleptic properties of bulk-brewed fresh coffee or tea. Such means are especially needed in relation to beverage dispensing machines, such as coin-freed vending machines, which dispense individual cups of beverage.

Hitherto, freshly brewed individual cups of coffee or tea have frequently been provided by means of coffee bags or tea bags. However, the coffee or tea bags require stirring to achieve a satisfactory infusion. Moreover, the quality of the coffee brewed using a coffee bag is inferior. This is because it is believed that good quality coffee is best obtained by passing hot water through the coffee grounds (perfusion) rather than by immersing the coffee grounds in hot water (infusion). As a result, coffee bags have not achieved wide acceptance.

As an alternative to coffee bags, individual cups of coffee can be brewed by perfusion using disposable coffee perfusers. These are generally in the shape of an open-ended tube having an external lip provided so that the tube can rest upright on top of a cup. The open-ended tube has two spaced-apart filters extending across the tube near its base, and ground coffee is provided in the space between the filters. Hot water is poured into the open-ended tube above the filters. It gradually trickles through the filters and the ground coffee and into the cup, to produce coffee freshly brewed by perfusion.

A drawback of the disposable coffee perfusers is that they are quite bulky, since the open-ended tube preferably needs to hold enough water for a whole cup of coffee in order to avoid the need to refill the tube with hot water. the bulky perfusers are difficult to incorporate into existing automatic beverage dispensing equipment.

Another drawback of the disposable coffee perfusers is that uneven sedimentation of the coffee grounds results in channelling of the hot water through particular regions of the coffee grounds, with the result that not all the coffee grounds are equally perfused.

Another drawback of the disposable coffee perfusers is that they are slow. Instead of the desired 60 seconds or less, the disposable coffee perfusers normally take 3 to 5 minutes to brew a cup of coffee. This is the time required for all of the water to pass through the bed of coffee grounds between the filter papers. The brewing time can be reduced by using coarser ground coffee, but this results in an unacceptably weak cup of coffee.

A further drawback of the disposable coffee perfusers is that, in use, there is a substantial risk of spilling hot water and/or coffee because of the top-heavy arrangement of a perfuser filled with water sitting atop an empty or near-empty cup. This problem is especially severe when the cup is a light-weight thermoformed plastics vending cup.

The present invention overcomes the above drawbacks of the prior art by providing a method and apparatus for brewing beverages of excellent quality at high speed and without risk of spillage. The present invention is especially suitable for use in beverage dispensing machines.

The present invention provides a method of brewing a beverage in a container such as a cup as claimed in claim 1 of the accompanying claims. The present invention also provides an apparatus to brew a beverage by the said method as claimed in claim 8, a beverage brewing capsule for use in the method of the invention as claimed in claim 14. The present invention also provides a cup having a beverage brewing capsule according to the invention resting in the bottom thereof, and an interlocked stack of such cups as claimed in claim 23.

According to the present invention it has been found that rapid brewing of good-qualify coffee can be achieved by: providing a container having a beverage brewing capsule located therein, the beverage brewing capsule comprising a

beverage brewing ingredient enclosed between two spaced-apart filtration barriers; pouring hot water into the container to at least partially immerse the beverage brewing capsule; and causing or allowing the beverage brewing capsule to move slowly in a vertical direction relative to the container.

Preferably, the capsule is initially located near the bottom of the hot-water container, such as a cup, and is lifted out at a constant vertical speed over a time of 30 to 90 seconds. Typically, the capsule is lifted out over a time of about 60 seconds. This results in a freshly brewed cup of coffee having satisfactory strength and excellent organoleptic properties. The method according to the present invention differs from the use of coffee perfusers according to the prior art in the following way. In the coffee perfusers, the hot water percolates through a stationary bed of coffee and trickles out through a filtration barrier at the bottom of the coffee bed into the cup. In the method of the present invention, the bed of coffee itself is moved through the hot water in the cup. The method of the present invention achieves more rapid perfusion and brewing of the coffee, apparently for the following reasons: (1) very little hydrostatic pressure is applied to the bed of coffee in the capsule, so that the coffee does not form a compacted bed of the type that resists the passage of water therethrough and gives rise to channelling and uneven perfusion, and (2) the lower filtration barrier of the coffee brewing capsule is normally immersed in water throughout the brewing process, so there is no surface tension to be overcome by water emerging from the bottom of the brewing capsule.

The slow vertical movement of the brewing capsule through the hot water in the container is preferably achieved merely by providing the capsule with suitable buoyancy in hot water, as described in more detail below. Alternatively, the capsule can be gripped and mechanically raised through the hot water. Alternatively or additionally, the container having the hot water therein can

be lowered relative to the capsule. In any case, the capsule preferably starts near the bottom of the container and travels at a substantially constant vertical speed to the top surface of the water in the container. Once the brewing process is complete the capsule is removed from the container and either discarded or recycled or refilled with fresh ground coffee or a similar beverage brewing ingredient.

Preferably, the container used for the method of the present invention is an individual cup, more preferably a thermoformed plastics vending cup.

Preferably, the beverage brewing capsule comprises a body in the shape of an open-ended tube, with the two spaced-apart filtration barriers extending across the tube substantially parallel to each other and substantially perpendicular to the longitudinal axis of the open-ended tube. Preferably, one or both of the filtration barriers is spaced from both ends of the open-ended tube.

The open-ended tube may be made of any suitable material, but is preferably made from thermoplastics material. Preferred thermoplastics materials are polystyrene or polypropylene. The open-ended tube is preferably made by thermoforming or injection moulding two or more pieces and then adhesively joining or heat-bonding the pieces together, as described in more detail below.

Preferably, at least one of the filtration barriers is spaced from both ends of the tube, and the capsule is buoyant when it is immersed in water at 90°C.

The buoyancy may be due to the use of low-density thermoplastics or, preferably, foamed thermoplastics in the construction of the capsule. Buoyancy may also be provided by means of an air chamber such as an air collar. The air chamber need not be completely enclosed but could take the form of an air pocket in which air is trapped as hot water is poured over the capsule. In any event, the capsule comprises some means to make it buoyant in water when in use.

The term "buoyant in water" implies that the capsule,

in use, has a net buoyancy equal to at least 10% of the dry weight of the capsule. that is to say, when the capsule is immersed in water at 90°C, the upward thrust due to the buoyancy of the capsule in grams force (1 gram force = 9.8 x 10^{-3}N) should be at least 10% of the dry weight of the capsule in grams. Preferably, the net buoyancy is at least 25% of the dry weight of the capsule, and more preferably the net buoyancy is at least 50% of the dry weight of the capsule.

In any case, the buoyancy of the capsule should be sufficient so that, in use, the buoyancy can lift an upper open end of the open-ended tube that is spaced from both filtration barriers above the surface of the liquid in a cup a sufficient distance to expose one of the filtration barriers above the surface of the liquid in the cup.

The beverage brewing capsule is preferably adapted to brew individual cups of beverage. Accordingly, the total internal volume of the open-ended tube is preferably between 50 ml and 150 ml. However, it will be appreciated that much larger capsules could be made for brewing much larger amounts of beverage. The volume defined inside the tube between the filtration barriers for holding the beverage brewing ingredient is preferably 5 ml to 50 ml. Also preferably, the volume of the cup shaped space defined between one end of the tube and the filtration barrier spaced from both ends of the tube is between 40 and 100 ml. In the event that each filtration barrier is spaced from both ends of the tube, then each of the cups defined thereby at opposite ends of the tube preferably has a volume between 40 and 100 ml.

The beverage brewing capsule is generally in the form of a tube open at both ends. The tube may be of any cross section, and need not be of constant cross section. However, preferably, the open-ended tube is of substantially circular cross-section, and preferably the outer surface of the tube is substantially cup-shaped so that the capsule fits neatly into the bottom of a cup with the outer surface of the open-ended tube close to or abutting the inner

surface of the cup.

Preferably, at least part of the outer surface of the open-ended tube is not smoothly curved, but is provided with projecting bumps or ribs, preferably longitudinally extending ribs, and preferably formed integrally with the open-ended tube by thermoforming or injection moulding. Preferably, the bumps or ribs project by 1.0-3.0 mm above the outer surface of the open-ended tube. The purpose of the projecting bumps or ribs is to ensure a minimum clearance between the outer surface of the open-ended tube and the inner surface of a cup when the capsule is in use, thereby eliminating undesirable effects caused by liquid trapped between the capsule and the cup by surface tension, as will be described further below.

Also preferably, an end of the open-ended tube that is spaced from both transverse filtration barriers and that faces upwardly when the capsule is in use is provided with inwardly extending notches or perforations. Preferably the notches or perforations extend a distance of 2.0-20 mm from the end of the tube. The purpose of the notches or perforations is to make the open-ended tube water permeable in the vicinity of the said open end, for reasons that will be described further below.

The beverage brewing capsule comprises a beverage brewing ingredient, such as ground coffee or leaf tea, provided inside the open-ended tube and between the spaced apart filtration barriers. The capsule may be demountable to allow insertion of a beverage brewing ingredient into the space between the two filtration barriers inside the open-ended tube. This arrangement also allows replacement of the beverage brewing ingredient after use and thereby permits the same capsule to be used for brewing multiple cups of beverage. It is preferred, however, that the capsule be non-reusable so that it is simply discarded after use.

The transverse filtration barriers extend completely across the inside of the open-ended tube. They are spaced apart, and at least one is spaced from both ends of the open-ended tube. The term "filtration barrier" encompasses

any barrier that allows the passage of water whilst substantially preventing the egress of solid beverage brewing ingredient from the space between the filtration barriers. Preferably, at least one of the filtration barriers comprises a layer of filtration material attached to the inside surface of the open-ended tube, for example by an adhesive or by heat bonding. Preferably, the filtration material is a filter paper, such as a filter paper of the type currently used to make tea bags or coffee bags. Such filter paper preferably comprises a mixture of cellulose and polypropylene fibres, and is heat-bondable to thermoplastics materials by virtue of the polypropylene fibres. However, it will be appreciated that the filtration barrier could alternatively or additionally comprise other materials, such as permeable plastics membranes or perforated metal foil.

Preferably, at least one of the filtration barriers is spaced from both ends of the open-ended tube. As a result, a cup shape is defined at one end of the tube, with the said at least one filtration barrier defining the base of the cup. Preferably, each of the filtration barriers is spaced from both ends of the tube so as to define back-to-back cup shapes at opposite ends of the tube, the base of each cup being a filtration barrier and the beverage brewing ingredient being located in the space between the filtration barriers, preferably about midway along the axis of the tube.

Preferably, the beverage brewing capsule is oriented with its longitudinal axis substantially parallel to the longitudinal axis of the container during the brewing process.

The method of the present invention is particularly well-suited for use in beverage dispensing machines operating on the "primed cup" (also known as "in-cup") principle. In these machines, one or more stacks of interlocked plastics cups are available to the user, the bottom of each cup containing an ingredient which produces a beverage when mixed with water (e.g. instant coffee or tea). When the user selects a beverage, the lowermost cup

is split from the bottom of the relevant stack and hot water is dispensed therein to mix with the ingredient or ingredients. Accordingly, in preferred embodiments, the present invention provides a method of brewing a beverage as above, wherein the steps of providing a container and a beverage brewing capsule located therein comprise providing a stack of cups each having a beverage brewing capsule located in the bottom thereof, and splitting the lowermost cup from the stack.

The present invention also provides an apparatus to brew a beverage by the method of the present invention, as claimed in claim 8. Preferably, the apparatus comprises a means to hold the beverage brewing capsule in the hot water and means to raise the capsule and/or lower the container having hot water therein. Preferably, the apparatus further comprises means to inject hot water into the container.

In preferred embodiments, the apparatus according to the present invention is a beverage dispensing machine, such as a coin-freed vending machine. Preferably, the dispensing machine is of the "primed-cup" type and includes means to store a stack of cups each containing a beverage brewing capsule, and means to split the lowermost cup from the stack.

The present invention also provides a cup having a beverage brewing capsule according to the invention resting in the bottom thereof. Preferably, the beverage brewing capsule is a buoyant beverage brewing capsule as described above.

A possible drawback of the present invention that can be predicted from previous experience with coffee perfusers is the problem of liquid dripping from the spent capsule immediately after it has been removed from the cup following the beverage brewing operation. This occurs because some liquid is retained in the bed of the beverage brewing ingredient and drips out through the lower filtration barrier immediately after removal of the capsule from the hot water. It has now been found that this problem can be overcome by providing a flexible water-impermeable film

extending across the bottom of the open-ended tube and sealed to the end of the open-ended tube around most, but not all, of the perimeter of the said end. During the brewing process, liquid passing through the lower filtration barrier can still escape from the capsule through the gaps that have been left between the flexible film and the perimeter of the open-ended tube. However, when the capsule is removed from the hot water in which the beverage has been brewed, the surface tension of the liquid trapped between the flexible film and the lip of the open-ended tube prevents further liquid from dripping out of the capsule. Accordingly, the cup according to the present invention preferably contains a capsule wherein a flexible film extends across an end of the open-ended tube and is attached thereto around part of the perimeter of the open-ended tube. Preferably, the flexible film is substantially impermeable to moisture and gases, and is sealed to the remainder of the perimeter of the open-ended tube by a heat-releasable adhesive. This allows the flexible film to act as a freshness barrier during storage of the capsule, but also to allow the passage of water through the capsule once it has been immersed in hot water and the heat-releasable adhesive releases the film around part of the perimeter of the open-ended tube. The opening of the freshness barrier film when the capsule is immersed in hot water may be assisted by the provision of a strip of heat-shrink material attached to the flexible film in a suitable orientation.

A second flexible film may be similarly attached adjacent to or inside the other end of the beverage brewing capsule above the upper filtration barrier in order to act as a freshness barrier. The second flexible film has a slit or line of weakness extending across it and a strip of heat-shrinkable material attached to it and extending away from the slit or line of weakness.

In an alternative preferred embodiment, the beverage brewing capsule is raised through the hot water in the cup by means of a strip of heat-shrinkable material, such as heat-shrinkable polyester or polyvinyl chloride (PVC),

attached at one end to the capsule and at the other end to the cup. When hot water is poured into the cup, the strip of heat-shrinkable material shrinks and thereby lifts the capsule towards the top of the cup. For balanced lifting of the capsule there should preferably be two or more such heat-shrinkable strips arranged circumferentially around the cup. Since the maximum heat-shrinkage that can be achieved with conventional heat-shrinkable materials is of the order of 40%, more complex configurations may be needed in order to lift the capsule to the top of the liquid in the cup. For example, the heat-shrinkable strip may be attached to one side of the bottom of the capsule, extended across the bottom of the capsule to the other side of the bottom of the capsule, and then extend up the side of the cup to an attachment point at the top of the cup. In this way, the total length of the heat-shrinkable strip is equal to the height of the cup plus the width of the capsule instead of just equal to the height of the cup. This arrangement results in proportionately greater vertical movement of the capsule when the hot water is poured into the cup.

The cup having the beverage brewing capsule therein according to the present invention should preferably be stackable to form interlocked stacks useable in "primed cup" dispensing machines. The interlocking of the cups also helps to keep the beverage brewing ingredients fresh, and for this reason the cups are preferably also provided with a resilient sealing lip, such as a PVDC (polyvinylidene chloride) sealing lip around an outside surface of the cup, which forms an interference sealing fit with an inside surface of an interlocked stacked cup.

The cup having the beverage brewing capsule located therein may also contain other beverage brewing ingredients, such as sugar or coffee whitener, either loose in the bottom of the cup or contained inside the beverage brewing capsule.

The present invention also provides an interlocked stack of cups as described above. The cups may be interlocked by a simple interference fitting, a snap fitting between annular ribs on the outside and inside of the cups, or by a

more complex interference fit.

Preferably, the beverage brewing capsule further comprises a reinforcing means extending across the open-ended tube adjacent to one or both of the filtration barriers. This is because fragile filtration barriers, such as filter papers, may sometimes rupture when water is first poured onto the capsule. The reinforcing means preferably comprises a rib extending across the open-ended tube, or a mesh of plastics material, preferably moulded in one piece with the open-ended tube.

Specific embodiments of the present invention will now be described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a longitudinal cross-section through a part of an apparatus according to the present invention in which a cup of coffee is being brewed by the method of the present invention;

Figure 2 shows a longitudinal cross-section through a cup having a beverage brewing capsule resting in the bottom thereof in accordance with the present invention;

Figure 3 shows a top plan view of the beverage brewing capsule shown in Figure 2;

Figure 4 shows a bottom plan view of the beverage brewing capsule shown in Figure 2;

Figure 5 shows a longitudinal cross-section through the cup and capsule combination of Figure 2 after hot water has been poured into the cup and while the coffee is brewing in accordance with the method of the present invention;

Figure 6 shows a longitudinal cross-section through the beverage brewing capsule of Figures 2 to 5 after the brewing process is complete and immediately after removing the capsule from the hot liquid in the cup.

Figure 7 shows a perspective view of a first alternative embodiment of the beverage brewing capsule according to the invention; and

Figure 8 shows a longitudinal cross section through a second alternative embodiment of the beverage brewing capsule according to the present invention.

Referring to Figure 1, the apparatus (1) comprises a support platform (2) for the cup (3) in which the beverage is to be brewed. The support platform (2) is mounted on vertically movable support (4), and a mechanism (not shown) provides for vertical motion of the support and platform at speeds suitable for brewing beverages by the method of the present invention. Typically, the platform must be capable of downward motion at controlled speeds in the range 1-5 cm per minute.

The apparatus (1) further comprises a yoke (5) to grip a beverage brewing capsule (6) in a vertically fixed position. Alternatively or additionally, the yoke (5) may be attached to a shaft (7) that is driven by a mechanism (not shown) for vertical movement of the capsule during the beverage brewing operation.

In use, the beverage is brewed as follows. First, with the platform (2) in the fully lowered position, the beverage brewing capsule (6) is inserted into the yoke (5) and a cup (3) is placed on the platform (2). The platform (2) is then raised until the bottom of the beverage brewing capsule rests against the bottom of the inside of the cup (3). Hot water at 80 to 100°C is then poured into the cup until the cup is nearly full. Immediately after filling the cup, the platform (2) begins to be lowered at a slow but constant rate of 5 cm per minute. Water from the upper part of the cup (3) perfuses through the upper and lower filtration barriers (8,10) and through the coffee grounds (9). Since there is almost no hydrostatic pressure difference across the top and bottom of the capsule, the coffee grounds do not form a compacted bed, but instead are free to swirl around between the two filtration barriers, which results in efficient, rapid and uniform perfusion of the coffee. Complete perfusion is achieved much more rapidly than with conventional coffee perfusers both because there is no compacted bed of coffee through which the water must pass and also because there are no surface tension effects at the lower filtration barrier tending to resist the flow of liquid out of the lower filtration barrier. The process is

timed so that after about 60 seconds the top filtration barrier of the beverage brewing capsule breaks the surface of the hot water in the cup. The platform (2) is then lowered rapidly until the capsule clears the top of the cup. The cup containing freshly brewed coffee can then simply be removed from the platform for consumption. The capsule is either discarded or emptied and refilled with fresh ground coffee.

Referring to Figure 2, the cup (11) is a thermoformed polystyrene cup of the kind already widely used for "primed cup" beverage dispensing systems. Two thermoformed indentations (12,13) extend around the cup respectively about one-third and two-thirds of the way down the side of the cup. A thin rib (14) of resilient PVDC resin is located above the lower indentation (13) and extends around the outside of the cup. When cups of this type are stacked, the rib (14) of resilient polymer forms a sealing interference fit with the inside surface of the upper part (12) of the next cup down in the stack. This helps to seal in the freshness of any beverage brewing ingredients inside the capsules (15) of the primed cup stack.

The beverage brewing capsule (15) comprises an open-ended tube 16 of generally frustoconical shape and made of polystyrene. A first filter paper 26 formed from cellulose and polypropylene fibres extends across the bottom of the tube and is secured to an inwardly projecting lip at the bottom of the tube 16 by heat sealing. A second filter paper 18 extends across the interior of the tube and is secured by heat sealing to an inwardly projecting ledge extending around the interior of the tube. The filter papers 18,20 divide the open-ended tube into a cup-shaped upper tube volume and a lower, enclosed tube volume, which contains ground coffee 19. An airtight air collar 17 extends around the lower, enclosed volume 8 to provide buoyancy.

The capsule measures approximately 6 cm in diameter by 4 cm in height. The weight of the capsule excluding the ground coffee is about 4g and the weight of the coffee is

about 6g. the volume of trapped air in the air collar is about 12 ml, and the net buoyancy of the capsule when immersed in water at 90°C is about 7 grams force (0.07N).

The beverage brewing capsule (15) shown in Figure 2 includes a further feature that a flexible film (23) extends across the bottom of the open-ended tube (16). The flexible film is preferably a moisture-and-oxygen barrier film, such as a polyethylene or polypropylene film.

Referring to Figure 3, the flexible film (23) is attached to the bottom lip (22) of the open-ended tube (16) around most of the perimeter thereof by means of a heat-stable attachment means, such as melt-sealing or a heat-stable adhesive. However, around a portion (24) of the perimeter of the lip (22) the flexible film (23) is attached thereto by means of a heat peelable adhesive, namely EVA (ethylene vinyl acetate) lacquer. A strip (25) of a heat-shrinkable polyester or PVC (polyvinyl chloride) is attached to the flexible film in the region (24) and extends diagonally across the surface of the flexible film 23.

Referring to Figure 4, a reinforcing rib (not shown) extends across the top and centre of the upper filter paper (18). A second flexible film (27) of an oxygen-and-water impermeable material such as polyethylene extends across the open-ended tube above the upper filter paper (18) and the reinforcing rib. A slit or line of weakness (28) extends across the middle of the second flexible film (27) above the reinforcing rib. Two strips of heat-shrinkable polyester or PVC (29,30) are attached to the second flexible film near the centre of the second flexible film and adjacent to either side of the slit or line of weakness (28). The two strips of heat-shrinkable material (29,30) extend perpendicularly away from the slit or line of weakness (28) and are attached at their distal ends to the edge of the second flexible film (27), or to the inside wall of the open-ended tube (16).

In use, hot water is poured into the cup having the beverage brewing capsule resting in the bottom thereof as shown in Figure 5. The hot water is directed onto the

reinforcing rib above the upper filter paper, and consequently the flow of water does not damage the upper filter paper (18). The hot water causes the upper heat-shrinkable strips (29,30) to shrink and thereby split the second flexible film (27) along the slit or line of weakness (28), thereby admitting the hot water into the brewing space between the filter papers (18,20). The hot water also releases the heat peelable adhesive in the region (24) of the lower lip (22) of the brewing capsule (15). This allows the flexible film (23) to peel away from the bottom of the brewing capsule (15) in the region (24), thereby allowing hot liquids to flow out from the bottom of the beverage brewing capsule. The opening of the lower flexible film is assisted by the lower heat-shrinkable strip (25). The Once the first and second flexible films have opened, the hot water passes freely through the filter papers (18,20) to immerse the coffee grounds (19) and commence the coffee brewing process. Once the coffee grounds (19) are fully wetted, liquid passes through the lower filter paper (20) into the bottom of the cup (11) and gradually fills the interstitial space between the outside of the capsule (15) and the inner surface of the cup (11). Once the level of liquid in this interstitial space has reached about half way up the capsule, the capsule becomes buoyant. The buoyancy of the capsule causes it to float slowly upwards until the top of the capsule just breaks the surface of the water at the top of the cup, as shown in Figure 5.

The capsule then proceeds to emerge more slowly from the surface of the water in the cup, as the water in the upper tube volume slowly trickles through the filter papers (18,20) and the coffee grounds (19). This movement of the water from the upper tube volume is driven by the buoyancy of the capsule (15), which lifts the surface of the water in the upper tube volume slightly above the surface of the body of water in the cu p, thereby generating a hydrostatic pressure difference across the coffee grounds (19).

The movement of the water from the upper tube volume back into the body of the cup is partially obstructed by the

filter papers (18,20) and the coffee grounds (19). As a result , it takes up to 3-4 minutes for all of the water from the upper tube volume to trickle through into the body of the cup. The total time occupied by this process can be controlled by varying such parameters as the filter paper porosity, the particle size of the coffee grounds, the packing density of the coffee grounds and the ratio of the volume of the coffee grounds to the volume of the enclosed space defined between the filter papers (18,20).

The slow passage of water from the upper tube volume through the coffee grounds (19) and into the body of the cup (11) results in effective perfusion of the coffee grounds and provides coffee having an authentic fresh-brewed taste. Moreover, the slow upward movement of the capsule maintains a fluid bed of coffee grounds throughout the perfusion process, thereby avoiding the problems of uneven sedimentation and channelling experienced with existing perfusers. Furthermore, the risk of spillage is much lower than with existing, top-heavy perfuser arrangements.

Once all of the water from upper tube volume has trickled back through filter paper (18), the capsule floats on the surface of the liquid in the cup. The buoyancy of the capsule is sufficient to lift the top filter paper (18) clear of the surface of the liquid in the cup. The emergence of the top filter paper from the liquid is a signal to the user that beverage brewing is substantially complete. The capsule can then be removed simply by grasping and lifting the upper end of the tube. Alternatively, the capsule may be provided with a handle or a string to assist removal. The handle may be formed integrally with the open-ended tube.

Referring to Figure 6, when the upper filter paper (18) breaks the surface of the liquid in the cup, thereby indicating that the brewing process is complete, the capsule is removed from the cup. The flexible film (23) is then attracted to the region (24) of the lower lip of the open-ended tube (16) by surface tension, and held there by the meniscus (26). This prevents leakage of any remaining water

in the capsule out of the bottom of the capsule after the capsule has been removed from the hot water in the cup.

Referring to Figure 7, a first alternative embodiment of the beverage brewing capsule according to the present invention is shown. The capsule (32) is of similar construction to the capsule (15) described above, comprising an open-ended tube (33) of thermoformed polystyrene material provided with an air collar (34) and two transversely extending filter papers. The capsule (32) is further provided with longitudinally extending ribs (35) formed integrally with the upper part of the capsule (32) and projecting by about 2 mm from the outer surface (38) of the capsule. In addition, slots (36) are cut in the open end (37) of the capsule (32) which is spaced from both filter papers and faces upward when the capsule is in use.

In use, the capsule (32) is used in the same way as described above. However, the longitudinal ribs (35) provide the advantage that they define a minimum spacing between the outer surface (38) of the capsule and the inner surface of the cup in which the beverage is being brewed. This minimum spacing is large enough to ensure that the meniscus of liquid between the capsule and the cup is substantially horizontal, so that surface tension forces are applied uniformly about the circumference of the capsule, and tipping of the capsule due to nonuniform surface tension is minimised or eliminated.

The purpose of the slots (36) is also to minimise tipping of the capsule in use. the inclusion of the slots (36) allows the height of the capsule (32) to be increased (and hence the angle through which the capsule can tip when in use to be reduced) without simultaneously increasing the volume of liquid that is trapped between the top open end of the tube and the central filter paper (39). An increase in this volume of liquid would result in an undesirable increase in the time taken to brew a beverage with the capsule.

Referring now to Figure 8, a second alternative embodiment of the beverage brewing capsule according to the

present invention is shown, in which each of the filtration barriers is spaced from both ends of the open-ended tube. The capsule (42) comprises an open-ended frustoconical polystyrene tube (43) formed from two pieces of thermoformed polystyrene heat bonded seams (47,48) to provide an air collar (44) extending around the interior of the tube approximately midway along the axis of the tube. The air collar (44) has upper and lower ledges (45,46), and filter papers comprising cellulose and polypropylene fibres (47,49), are heat bonded to these ledges to form the upper and lower filtration barriers. The filter papers (47,49) divide the tube onto an upper cup-shaped end region (50), a central enclosed region (51) which contains ground coffee (not shown), and a lower cup-shaped end region (52).

The capsule (42) is used in the same way as described above. However, the presence of the lower end region (52) means that there is an initial, fast perfusion step as the hot water is poured into upper end region (50) and flows through the filter papers (47,49), and the ground coffee in region (51) into lower end region (52). Once the capsule (42) is fully immersed it floats to the top of the cup and a slow perfusion takes place as described above. The sequence of fast and slow perfusion steps results in a coffee having improved organoleptic properties.

Another advantage of the capsule (42) is that the ratio of the height to the diameter of the capsule (42) is increased relative to that of capsule (15) or capsule (32). This helps to reduce the angle through which the capsule (42) can tip in use. A further advantage of the capsule (42) is that the volume (52) can accommodate whiteners, sugar, artificial sweeteners and/or other water soluble beverage ingredients. This feature is especially useful when stacks of interlocking cups having beverage brewing capsules sealed therein are being provided for use in beverage dispensing machines.

It can thus be seen that the present invention provides an improved method and apparatus for fresh brewing of beverages by perfusion. The method according to the present

invention is faster than existing coffee perfusers and does not present the same risks of spillage. The method is particularly well suited for use in conjunction with primed-cup dispensing machines. The flexible films above and below the filtration barriers of the beverage brewing capsule not only allow the problem of liquid leakage from the bottom of the capsule after the brewing operation is completed to be greatly reduced, but also function as freshness seals permitted long storage of the capsules. Freshness of the beverage brewing ingredients is further assured by the provision of stacked in-cup beverage brewing capsules, optionally with a resilient lip forming a freshness seal between successive cups in the stack.

The above embodiments have been described for the purpose of illustration only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

CLAIMS:

1. A method of brewing a beverage in a container such as a cup, the method comprising the steps of:

providing a container having a beverage brewing capsule located therein, the beverage brewing capsule comprising a beverage brewing ingredient enclosed between two spaced-apart filtration barriers;

pouring hot water into the container to at least partially immerse the beverage brewing capsule; and

causing or allowing the beverage brewing capsule to move slowly in a vertical direction relative to the container.

2. A method of brewing a beverage according to claim 1, wherein the beverage brewing capsule comprises a body in the shape of an open-ended tube, with the two spaced-about filtration barriers extending across the tube substantially perpendicular to the longitudinal axis of the tube.

3. A method of brewing a beverage according to claim 1 or 2, wherein the beverage brewing capsule is raised slowly through the hot water in the container by a capsule lifting means attached to the capsule.

4. A method of brewing a beverage according to claim 1, 2 or 3, wherein the container is lowered slowly by a container lowering means.

5. A method of brewing a beverage according to any preceding claim, wherein the capsule comprises buoyancy means and the capsule rises slowly through the hot water in the container due to its own buoyancy.

6. A method of brewing a beverage according to any preceding claim, wherein the beverage brewing time is from 30 to 90 seconds.

7. A method of brewing a beverage according to any

preceding claim, wherein the step of providing a container having a beverage brewing capsule located therein comprises the steps of: providing a stack of cups each having a beverage brewing capsule located in the bottom thereof, and splitting the lowermost cup from the stack.

8. An apparatus to brew a beverage by a method according to any preceding claim, the apparatus comprising:

means to support a container such as a cup;

means to hold a beverage brewing capsule inside the container, the beverage brewing capsule comprising a beverage brewing ingredient enclosed between two spaced-apart filtration barriers, and

means to move the beverage brewing capsule in a vertical direction relative to the container.

9. An apparatus to brew a beverage according to claim 9, wherein the apparatus comprises means to raise the capsule.

10. An apparatus to brew a beverage according to claim 9, wherein the apparatus comprises means to lower the container.

11. An apparatus to brew a beverage according to claim 9, 10 or 11, further comprising means to pour hot water into the container having the beverage brewing capsule held therein.

12. An apparatus to brew a beverage according to any of claims 9 to 12, further comprising means to store a stack of cups and means to split the lowermost cup from the stack.

13. An apparatus to brew a beverage according to any of claims 9 to 13 which is a beverage dispensing machine.

14. A beverage brewing capsule for use in a method according to any of claims 1 to 7, the capsule comprising a body in the form of an open-ended tube, two spaced-apart

filtration barriers extending across the tube and a beverage brewing ingredient located between the filtration barriers.

15. A beverage brewing capsule according to claim 14, wherein at least one of said filtration barriers is spaced from both ends of the tube, and wherein the beverage brewing capsule is buoyant in water at about 90°C.

16. A beverage brewing capsule according to claim 14 or 15 wherein the open-ended tube has a substantially circular cross-section.

17. A beverage brewing capsule according to claim 14, 15 or 16 wherein the exterior surface of the open-ended tube is substantially cylindrical or frustoconical.

18. A beverage brewing capsule according to any of claims 14 to 17, wherein projecting bumps or ribs are provided on an exterior surface of the open-ended tube.

19. A beverage brewing capsule according to claim 18 wherein the projecting bumps or ribs comprise longitudinally extending ribs spaced around the perimeter of the exterior surface.

20. A beverage brewing capsule according to any of claims 14 to 19, wherein slots or perforations are provided in the open-ended tube adjacent to an end of the tube that is spaced from both filtration barriers.

21. A beverage brewing capsule according to any of claims 14 to 20 wherein at least one of the transverse filtration barriers comprises a layer of filtration material attached to an inside surface of the open-ended tube.

22. A beverage brewing capsule according to claim 21, wherein the filtration material is a filter paper.

23. A beverage brewing capsule according to any of claims 14 to 22 further comprising an air chamber to provide buoyancy.

24. A beverage brewing capsule according to claim 23 wherein the air chamber is an air collar.

25. A beverage brewing capsule according to any of claims 14 to 24, wherein the open-ended tube is at least partially formed from a foamed plastics material.

26. A beverage brewing capsule according to any of claims 14 to 25 which is demountable to allow replacement of a beverage brewing ingredient inside the tube between the two filtration barriers.

27. A beverage brewing capsule according to any of claims 14 to 26 wherein each of the filtration barriers is spaced from both ends of the open-ended tube.

28. A beverage brewing capsule according to any of claims 14 to 27 wherein the volume of the open-ended tube is between 50 ml and 150 ml.

29. A beverage brewing capsule according to any of claims 14 to 28 wherein the volume defined inside the tube and between the two filtration barriers is between 5 ml and 50 ml.

30. A beverage brewing capsule according to any of claims 14 to 29 wherein the volume of a cup defined inside the tube between at least one of said filtration barriers and an end of the tube is between 40 and 100 ml.

31. A beverage brewing capsule according to any of claims 14 to 30, wherein a flexible film extends across the bottom of the open-ended tube and is attached thereto around part of the perimeter of the open-ended tube by a heat-peelable

adhesive.

32. A beverage brewing capsule according to claim 31, wherein a strip of heat-shrinkable material is attached to the flexible film.

33. A beverage brewing capsule according to claim 31 or 32, further comprising a second flexible film extending across the open-ended tube above the upper filtration barrier, said second flexible film having a slit or line of weakness extending across it and a strip of heat-shrinkable material attached to the second flexible film and away from the slit or line of weakness.

34. A beverage brewing capsule according to any of claims 14 to 33, further comprising a reinforcing means extending across the open-ended tube adjacent to one or both of the filtration barriers.

35. A beverage brewing capsule according to claim 34, wherein the reinforcing means comprises a rib or a mesh of plastics material.

36. A cup having a beverage brewing capsule according to any of claims 14 to 35 resting in the bottom thereof.

37. A cup according to claim 36, further comprising a strip of heat-shrinkable material attached at one end to the capsule and at its other end to the cup.

38. A cup according to claim 37, wherein the strip of heat-shrinkable material is attached at one end to the first side of the base of the capsule and extends across the base of the capsule and up the side of the cup and is attached at its other end to the cup near the top of the cup.

39. A cup according to any of claims 36 to 38, wherein the resilient sealing lip extends around an outside surface of

the cup.

40. An interlocked stack of cups obtained by stacking two or more cups according to any of claims 36 to 39.

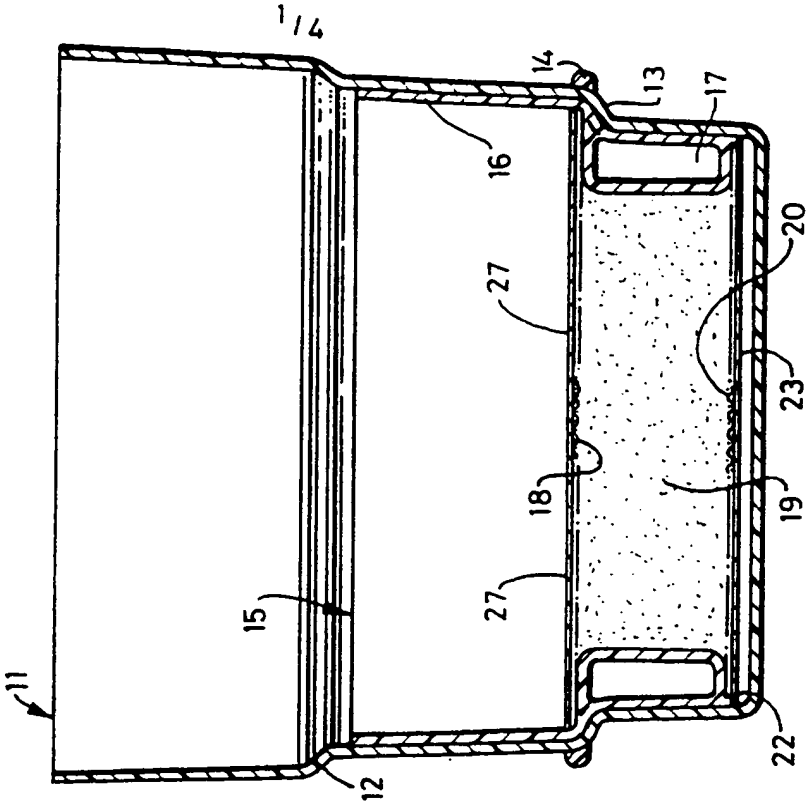


FIG. 2

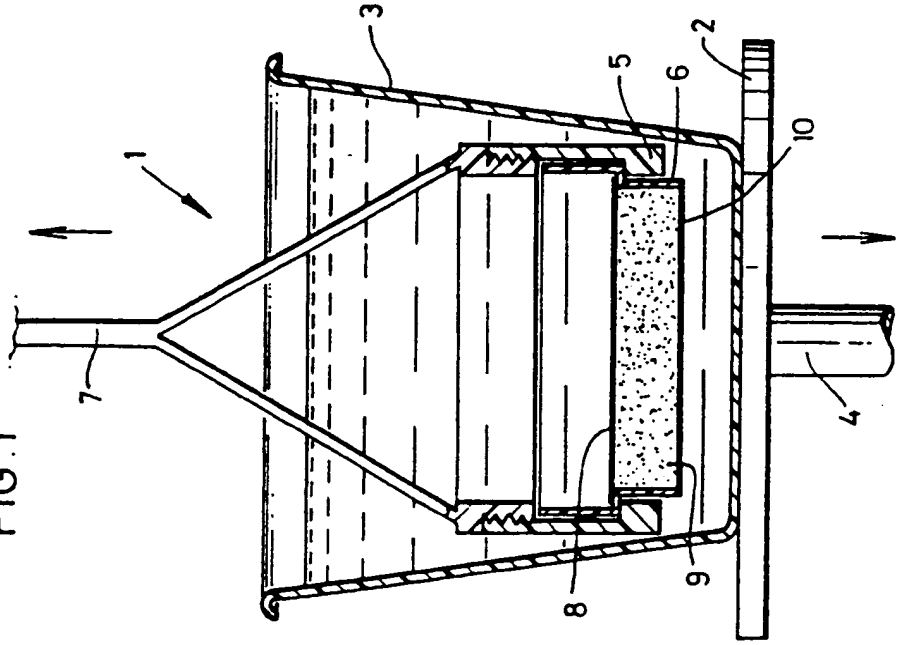


FIG. 1

FIG. 3

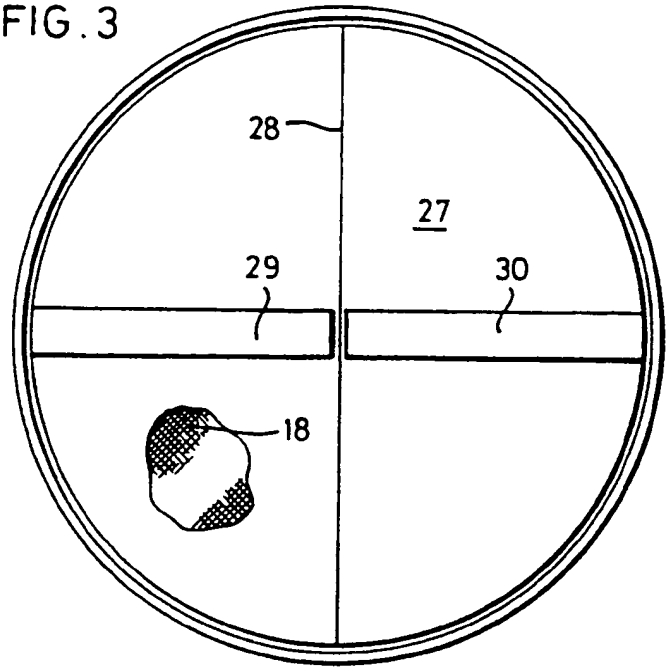


FIG. 4

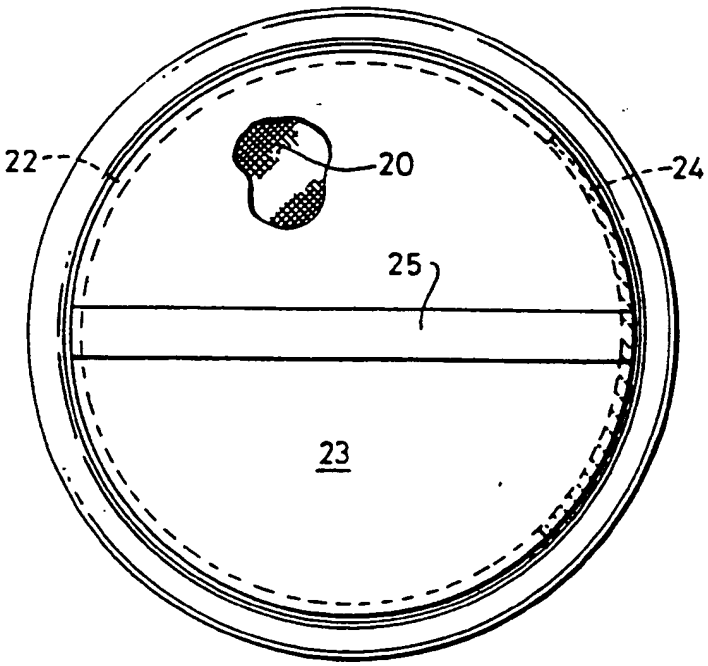


FIG. 5

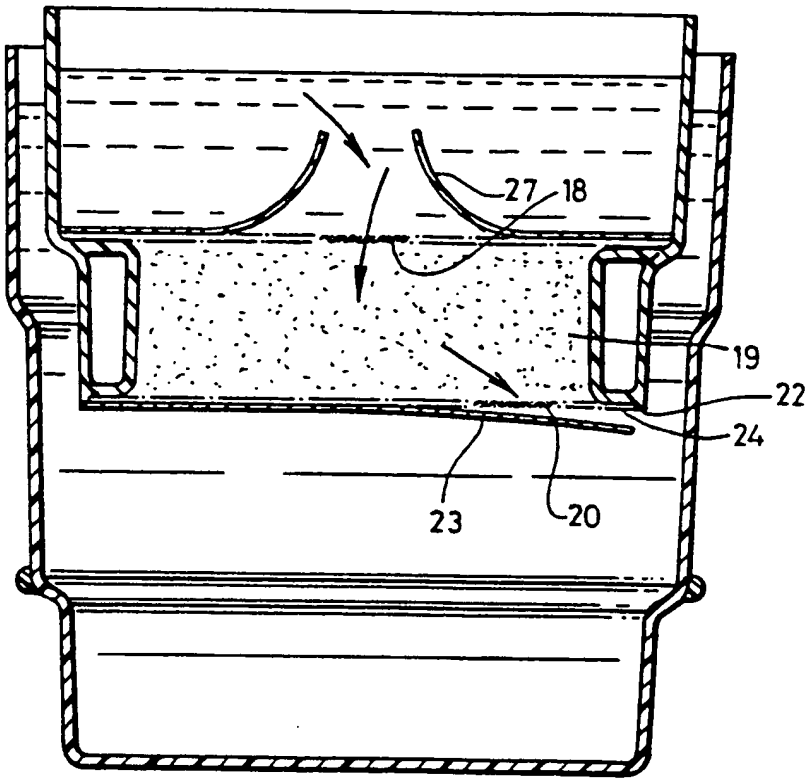


FIG. 6

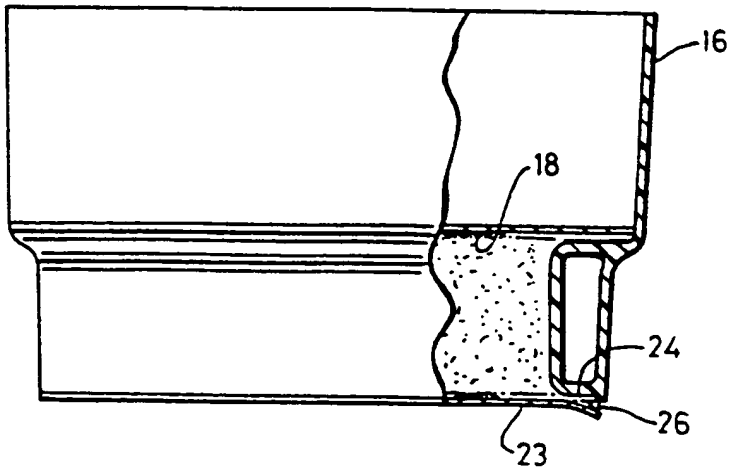


FIG. 7

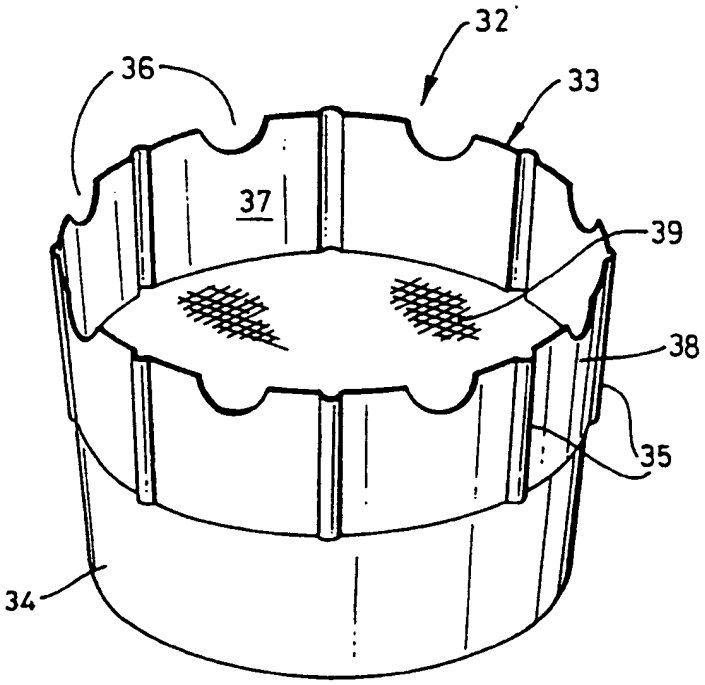
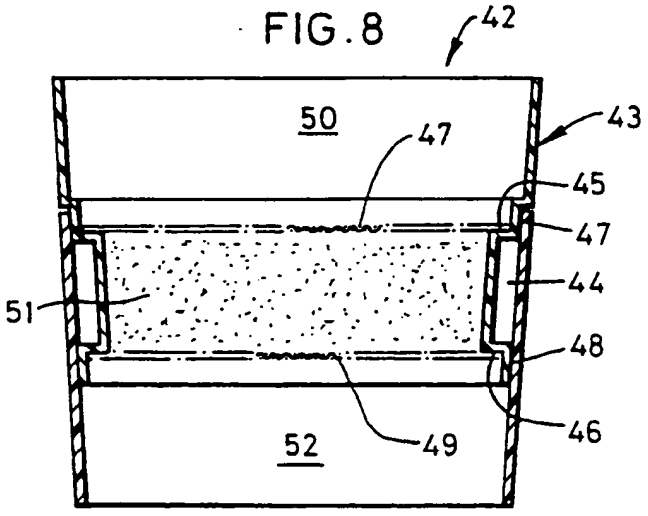


FIG. 8



INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PCT/GB 94/02009

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A47J31/20 B65D81/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A47J B65D A47G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 094 368 (N.F. VANDERPLAETSE) 16 November 1983	1-3,5, 7-9, 11-17, 21-25, 27,36, 39,40
Y	see page 3, line 1 - line 17; figures 1,4,6 ---	6,28-30, 34,35
Y	EP,A,0 224 297 (DOUWE EGBERTS KONINKLIJKE TABAKSFABRIEK-KOFFIEBRANDERIJEN-THEEHANDEL NV) 3 June 1987 see figures 2,7; example ---	6,28-30, 34,35
X	DE,A,27 58 184 (BRAUN AG) 28 June 1979 see page 4, paragraph 5; figure 1 ---	1,14,23, 26
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 December 1994	- 6. 01 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	SCHMITT, J

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 94/02009

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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